Remarks

Claims 1-40 and 59-71 have been cancelled. Claims 72 to 197 have been added. Support for the added claims is found the specification as originally filed. No new matter has been added. The references will be discussed in reference to the new claims.

Claim 72

72. A memory element, comprising:

a programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material, said first region being remote to said programmable resistance material, said electrical contact comprising a conductive layer, said second region being a modified portion of said conductive layer.

Gonzalez (US 5,854,102)

Gonzalez (referring to Figure 8 and column 8, lines 8-20) teaches a polysilicon diode 38 in electrical communication with the programmable resistor 46. The polysilicon diode comprises a top portion 42 which is adjacent to the programmable resistor 46 and a bottom portion 44 which is remote to the programmable resistor 46. The top (adjacent) portion 42 is heavily doped (col 8, line 12). The bottom (remote) portion 44 is lightly doped (col 8, line 19).

The heavier the doping of a semiconductor material, the lower the resistivity. Please refer to Appendix A to this Response (Microchip Fabrication, Peter Van Zant, Fourth Edition, McGraw Hill, page 33) which shows a graph of silicon resistivity versus doping concentration. Please note that the Resistivity (horizontal axis) goes down as the carrier concentration (amount of doping goes up). This is true for both p and n type dopants.

Hence, in the case of Gonzalez' diode 38, the portion which is adjacent to the programmable resistor is more heavily doped and this, according to the graph of Appendix A implies that the adjacent portion of the diode has the lower resistivity. This teaches away from applicant's claimed invention where the region adjacent to the

programmable resistance material has the higher resistivity. Hence, Gonzalez does not teach applicant's claimed invention as recited in claim 72.

Ovshinsky (US 5,687,112)

Ovshinsky '112 teaches (see Figure 2) an electrical contact having a first conductive layer 14 and a second conductive layer 34. Hence, the electrical contact shown in Figure 2 of Ovshinsky '112 comprises two separate layers of conductive material. In contrast, the electrical contact, as claimed in applicants claim 72, comprises a first and second region where both the first and second regions are formed from the same conductive layer. As recited in claim 72, the second region is a modified portion of the conductive layer (it is not a separate conductive layer). Hence, Ovshinsky '112 fails to teach or suggest applicants invention.

Ovshinsky (US 5,414,271)

Ovshinsky '271 also shows an electrical contact (see Figure 1) which comprises two separate layers of conductive material (layers 32 and 34).

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a

first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 88

88. A memory element, comprising:

a programmable resistance material; and

an electrical contact in electrical communication with programmable resistance material, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material, said first region being remote to said programmable resistance material, said electrical contact comprising polysilicon.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest an electrical contact comprising polysilicon.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact comprising polysilicon.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 104

104. A memory element, comprising:

a programmable resistance programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material, said first region being remote to said programmable

resistance material, said first region being doped differently from said second region.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest an electrical contact having first and second regions that are doped differently.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact having first and second regions that are doped differently.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 119

119. A memory element, comprising:

a substrate;

a programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material and said substrate, substantially all of said electrical communication between said electrical contact and said programmable resistance material occurring through at least a portion of an edge of said electrical contact, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region adjacent to said programmable resistance material and spacedly disposed from said substrate, said first region being spacedly disposed from said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical

communication between the contact and the programmable resistance material occurs through an edge portion of the contact.

Ovshinsky (US 5,687,112)

Referring to Figure 2 of Ovshinsky '112, it is seen that the bottom of layer 34 touches the substrate 10. Hence, Ovshinksy '112 does not teach or suggest an electrical contact having a less resistive first region and a more resistive second region, where the second region is spacedly disposed from the substrate. Again referring to Figure 2, the layer 34 is not spacedly disposed from the substrate 10 since is actually touches the substrate 10.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact where substantially all electrical communication between the electrical contact and the programmable resistance material is through an edge portion of the electrical contact.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a

first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 138

1. A memory element, comprising:

a programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material, substantially all of said electrical communication occurring through at least a portion of an edge of said electrical contact, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material while said first region is remote to said programmable resistance material, at least a portion of said electrical contact being formed over at least a portion of a dielectric layer.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance

material. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical communication between the contact and the programmable resistance material occurs through an edge portion of the contact.

Ovshinsky (US 5,687,112)

Referring to Figure 2 of Ovshinsky '112, it is seen that the electrical contact (34,14) comprise two separate conductive layers, conductive layer 34 and conductive layer 14. Conductive layer 14 is formed over the substrate 10. The conductive layer 34 is formed over the conductive layer 14. In addition, the dielectric layer 18 is formed over the conductive layer 34. Hence, in Ovshinsky '112 Figure 2 the dielectric layer 18 is formed over the electrical contact (34,14) (see Ovshinky '112 col 15, lines 57 to 59). This is also true in Ovshinsky '112 Figure 1 where dielectric layer 18 is formed over electrical contact (14).

In is distinct from applicant invention as recited in claim E where at least a portion of the electrical contact is formed over at least a portion of a dielectric layer. For example, see applicants Figure 2C where conductive layer 133 is formed over the sidewall surface of dielectric layer 128. Hence, in applicant's invention as recited in claim 138, dielectric and conductive layers are deposited

onto a substrate in an a order which is different from that taught by Ovshinsky '112 thereby producing an electrical contact structure which is different from that taught by Ovhshinsky '112.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact where substantially all electrical communication between the electrical contact and the programmable resistance material is through at least a portion of an edge of the electrical contact.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 150

1. A memory element, comprising:

a programmable resistance material; and

a conductive sidewall spacer formed over a sidewall surface of a dielectric layer, said conductive spacer in electrical communication with said programmable resistance material, substantially all of said electrical

communication between said electrical contact and said programmable resistance material occurring through at least an edge portion of said conductive spacer, said electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material, said first region being remote to said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical communication between the contact and the programmable resistance material occurs through at least a portion of an edge of the contact.

Ovshinsky (US 5,687,112)

Same argument as above. It is emphasized that the conductive layer 34 is formed over conductive layer 14

(Figure 2). The conductive layer 34 is NOT formed over the sidewall surface of a dielectric layer.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact where substantially all electrical communication between the electrical contact and the programmable resistance material is through at least a portion of an edge of the electrical contact.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 158

1. A memory element, comprising:

a programmable resistance material; and

a conductive liner that lines the sidewall and bottom surfaces of an opening of a dielectric material, said conductive liner in electrical communication with said programmable resistance material, substantially all of said electrical communication between said conductive liner and said programmable resistance material occurring through at

least a portion of an edge of said conductive liner, said conductive liner having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region being adjacent to said programmable resistance material, said first region being remote to said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical communication between the contact and the programmable resistance material occurs through at least a portion of an edge portion of the contact.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest a conductive liner that lines the bottom surface and sidewall surface of an opening formed in a dielectric layer.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact where substantially all electrical communication between the electrical contact and the programmable resistance material is through at least a portion of an edge of the electrical contact.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 170

1. A memory element, comprising:

a programmable resistance material; and

a cup-shaped electrical contact in electrical communication with said programmable resistance material, wherein substantially all of said electrical communication occurring through at least a portion of a rim of said electrical contact, said electrical contact including a first portion having a first resistivity and a second portion having a second resistivity greater than said first resistivity, said second portion being adjacent said

programmable resistance material, said first portion being remote to said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material. Gonzalez fails to teach or suggest a cup-shaped electrical contact. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical communication between the contact and the programmable resistance material occurs through at least a portion of a rim of the contact.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest a cup-shaped electrical contact.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest a cup-shaped electrical contact where substantially all electrical communication between the electrical contact and the programmable resistance material is through at least a portion of a rim of the electrical contact.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

Claim 177

1. A memory element, comprising:

a programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material, said electrical contact having at least a portion of an edge that includes one or more raised portions, substantially all of said electrical communication between said electrical contact and said programmable resistance material occurring through at least a portion of the surface of at least one of said raised portions, said electrical contact having at least first region with a first resistivity and a second region with a second resistivity greater than said first resistivity, said second region adjacent said programmable resistance material, said first region remote to said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest an electrical contact having at least a portion of an edge that includes one or more raised portions where substantially all electrical communication between the contact and the programmable resistance material is through at least a portion of the surface of at least one of the raised portions.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact having at least a portion of an edge that includes one or more raised portions extending where substantially all electrical communication between the contact and the programmable resistance material is through at least a portion of the surface of at least one of the raised portions.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity. Also, Tanahashi does not teach or suggest an electrical contact having at least a portion of an edge that includes one or more raised portions.

Claim 190

1. A memory element, comprising:

a programmable resistance programmable resistance material; and

an electrical contact in electrical communication with said programmable resistance material, substantially all of said electrical communication being through at least a portion of an edge of said electrical contact, said at least a portion of said edge at least partially encircling said programmable resistance material, said electrical contact having a first portion with a first resistivity and a second portion with a second resistivity greater than said first resistivity, said second portion being adjacent

said programmable resistance material, said first portion being remote said programmable resistance material.

Gonzalez (US 5,854,102)

As noted above, Gonzalez does not teach or suggest an electrical contact having a more resistive second region adjacent to a programmable resistance material and a less resistance first region remote to a programmable resistance material. Also, Gonzalez failed to teach or suggest an electrical contact where substantially all electrical communication between the contact and the programmable resistance material occurs through at least a portion of an edge of the contact.

Ovshinsky (US 5,687,112)

Ovshinsky '112 does not teach or suggest an electrical contact in electrical communication with said programmable resistance material where substantially all of the electrical communication is through at least a portion of an edge of the electrical contact and the edge (or portion thereof) at least partially encircles the programmable resistance material.

Ovshinsky (US 5,414,271)

Ovshinsky '271 does not teach or suggest an electrical contact in electrical communication with said programmable

resistance material where substantially all of the electrical communication is through at least a portion of an edge of the electrical contact and the edge (or portion thereof) at least partially encircles the programmable resistance material.

Tanahashi (US 6,064,084)

Tanahashi is not related to programmable resistance materials and, furthermore, does not teach or suggest an electrical contact having at least a first region with a first resistivity and a second region with a second resistivity greater than said first resistivity.

In view of applicant's cancellation of claims 1-40 and 59-71, the claim rejections under 35 USC 112 (paragraph 2 of Office Action), 35 USC 102 and 35 USC 103 (paragraphs 4, 5, 7, and 9 of the Office Action) have been overcome and applicant's request they be removed.

In view of the above remarks, each of the references provided (Gonzalez '102, Ovshinsky '112, Ovshinsky '271, and Tanshashi '084), either alone or in combination, fails to teach or suggest applicants invention as recited in the new independents claims 72, 88, 104, 119, 138, 150, 158, 170, 177, 190. All remaining dependent claims include all of the limitations of their respective independent claim.

Hence, the references provided fails to teach or suggest all of the limitations of any of the dependent claims.

Summary

Claims 1-40 and 59-71 have been cancelled. New claims 72 to 197 have been added. In view of the above remarks, the new claims 72 to 197 are in condition for allowance. Applicants respectfully request reconsideration and withdrawal of the outstanding rejections and notification of allowance. Should the Examiner have any questions or suggestions regarding the prosecution of this application, he is asked to contact applicants' representative at the telephone number listed below.

Respectfully submitted,

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Appendix A

Microchip Fabrication

A Practical Guide to Semiconductor Processing

Peter Van Zant

Fourth Edition

McGraw-Hill

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Caracas Lisbon London Madrid Mexico City Milan
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Figure 2.7 shows the relationship of the doping level to the resistivity of silicon. The x-axis is labeled the carrier concentration because the electrons or holes in the material are called carriers. Note that there are two curves: N-type and P-type. That is due to the different amount of energies required to move an electron or a hole through the material. As the curves indicate, it takes less of a concentration of N-type dopants than P-type dopants to create a given resistivity in silicon. Another way to express this phenomenon is that it takes less energy to move an electron than move a hole.

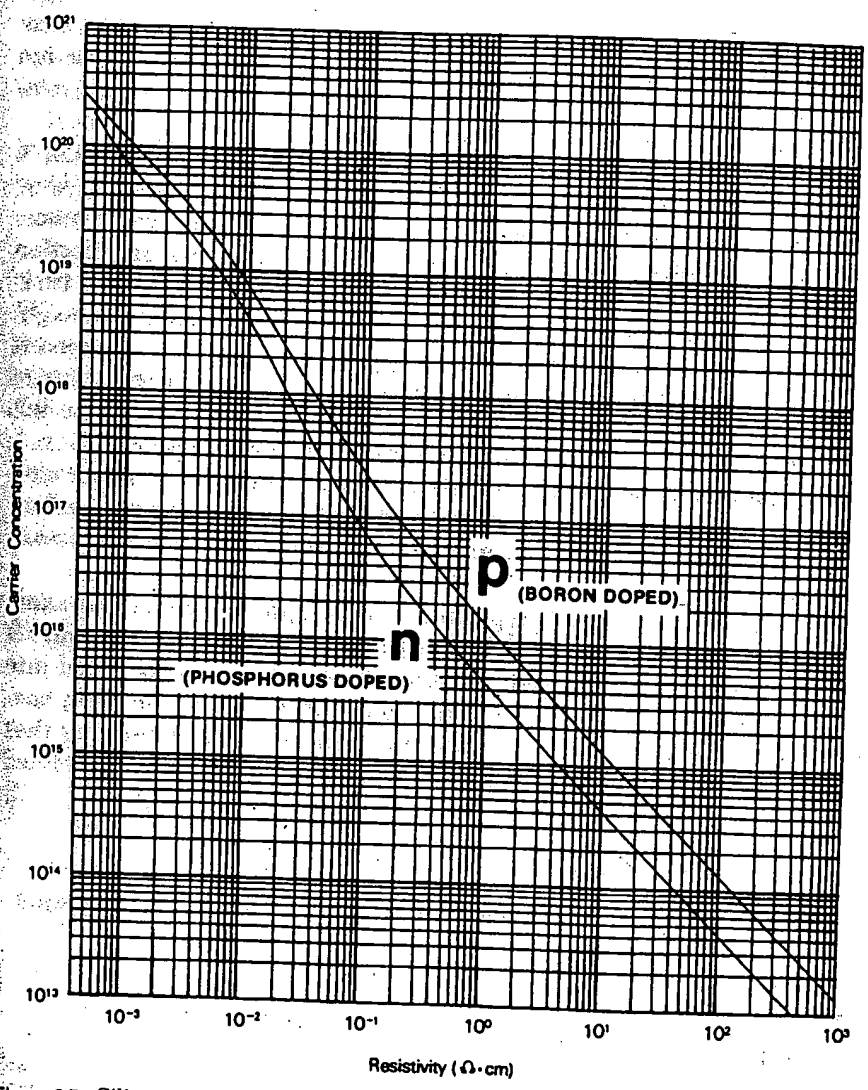

Figure 2.7 Silicon resistivity versus doping (carrier) concentration. (*After Thurber et al., Natl. Bur Standards Spec. Publ. 400-64, May 1981, tables 10 and 14.*)